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(54) METHOD AND APPARATUS FOR TRANSFERRING ARTICLES BETWEEN TWO CONTROLLED ENVIRONMENTS.

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Description

CROSS-REFERENCE TO RELATED APPLICATIONS AND PATENTS

This Application is related to the following Applications/Patents, all assigned to the assignee of the subject Application:

SEALED STANDARD INTERFACE APPARATUS, Inventors: George Allen Maney, Andrew William O'Sullivan, W. George Faraco, Serial No. 635,384, Filed: July 30, 1984, U.S. Patent No. 4,674,939;

INTELLIGENT WAFER CARRIER, Inventors: George Allen Maney, Anthony Charles Bonora, Mihir Parikh, Serial No. 686,444, Filed: December 24, 1984, U.S. Patent No. 5,097,421;

DOOR ACTIVATED RETAINER, Inventors: George Allen Maney, W. George Faraco, Mihir Parikh, Serial No. 686,443, Filed: December 24, 1984, U.S. Patent No. 4,815,912;

LONG ARM MANIPULATOR FOR STANDARD MECHANICAL INTERFACE APPARATUS, Inventors: Anthony Charles Bonora, Andrew William O'Sullivan, Serial No. 769,709, Filed: August 26, 1985, U.S. Patent No. 4,676,709;

SHORT ARM MANIPULATOR FOR STANDARD MECHANICAL INTERFACE APPARATUS, Inventors: Anthony Charles Bonora, Serial No. 769,850, Filed: August 26, 1985, U.S. Patent No. 4,674,936;

CONTAINER HAVING DISPOSABLE LINERS, Inventors: Mihir Parikh, Anthony Charles Bonora, W. George Faraco, Barney H. Huang, Serial No. 829,447, Filed: February 13, 1986, U.S. Patent No. 4,739,882;

SEALABLE TRANSPORTABLE CONTAINER HAVING A PARTICLE FILTERING SYSTEM, Inventors: Mihir Parikh, Anthony C. Bonora, Serial No. 840,380, Filed: May 1, 1986, U.S. Patent No. 4,724,874; and

SEALABLE TRANSPORTABLE CONTAINER HAVING IMPROVED LATCH MECHANISM, Inventors: Anthony Charles Bonora, Frederick Theodore Rosenquist, Serial No. 354,027, Filed: May 19, 1989, U.S. Patent No. 4,995,430.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to standardized mechanical interface (SMIF) systems for reducing particle contamination, and more particularly to systems for transferring articles from a transportable container (e.g. a SMIF pod), which is sealable to prevent influence of external factors on the contents of the container, to a processing station, and returning articles from the processing station to the transportable container.

Description of the Related Art

A standardized mechanical interface (SMIF) system has been proposed by the Hewlett-Packard Company as disclosed in U.S. Patent No. 4,532,970 and 4,534,389. The purpose of the SMIF system is to reduce particle fluxes onto articles, for example, semiconductor wafers. This end is accomplished, in part, by mechanically ensuring that during transportation and storage the gaseous media (such as air or nitrogen) surrounding the wafers is essentially stationary relative to the wafers and by ensuring that particles from the ambient environment do not enter the immediate wafer environment.

The SMIF concept is based on the realization that a small volume of controlled (with respect to motion, air flow direction and external contaminants), particle-free air provides a clean environment for wafers. Further details of one proposed system are described in the article entitled "SMIF: A TECHNOLOGY FOR WAFER CASSETTE TRANSFER IN VLSI MANUFACTURING," by Mihir Parikh and Ulrich Kaempf, Solid State Technology, July 1984, pp. 111-115. SMIF systems are concerned with particle sizes which range from below 0.1 micrometers (microns) to above 200 microns. Particles with these sizes can be very damaging in semiconductor processing because of the small geometries employed in fabricating semiconductor devices. Typical advanced semiconductor processes today employ geometries which are 1 micron and under. Unwanted contamination particles which have geometries measuring greater than 0.05 microns substantially interfere with 1 micron geometry semiconductor devices. The trend, of course, is to have smaller and smaller semiconductor processing geometries which today in research and development labs approach 0.5 microns and below. In the future, geometries will become smaller and smaller and hence smaller and smaller contamination particles become of interest.

A SMIF system has three main components: (1) minimum volume, sealed pods used for storing and transporting wafer cassettes; (2) canopies placed over cassette ports and wafer processing areas of processing equipment so that the environments inside the pods and canopies (after having clean air

sources) become miniature clean spaces; and (3) a transfer mechanism to load/unload wafer cassettes from a sealed pod without contamination of the wafers in the wafer cassette from external environments.

Wafers are stored and transported in pods, and are transferred from a pod to a piece of processing equipment in the following manner. First, a pod is placed at the interface port on top of the canopy. Each pod includes a box and a box door designed to mate with doors on the interface ports of the processing equipment canopies. Then, latches release the box door and the canopy port door simultaneously; the box door and the interface port door are opened simultaneously so that particles which may have been on the external door surfaces are trapped ("sandwiched") between the box and interface port doors. A mechanical elevator lowers the two doors, with the cassette riding on top, into the canopy covered space. A manipulator picks up the cassette and places it onto the cassette port/elevator of the equipment. After processing, the reverse operation takes place.

In U.S. Patent No. 4,724,874 a SMIF pod is disclosed in which a fitting is provided in the SMIF pod to allow fluids to be removed from or introduced to the interior region on the SMIF pod. The fitting provides communication between the interior region of the SMIF pod and the region outside the SMIF pod, and may be used, for example, to create a vacuum in the interior of the SMIF pod, to create an over-pressure in the interior region of the SMIF pod, and/or to introduce fluids (gases), such as helium, nitrogen, or other selected gases, into the interior region of the SMIF pod.

Processing stations, which receive materials to be processed from SMIF pods, may include an interior region having an atmosphere which is maintained as controlled humidity e.g., dehumidified air, nitrogen, argon, or another appropriate gas. In situations where the processing equipment has a controlled atmosphere, it is desirable to prevent contamination of the controlled atmosphere in the processing equipment when loading articles from a SMIF pod to the processing equipment. One mechanism for preventing such contamination is to use the SMIF pod disclosed in U.S. Patent No. 4,724,874, and to control the environment in the interior region of the SMIF pod by the removal or introduction of appropriate gases into the SMIF pod. However, many SMIF pods currently in use do not have a facility for controlling the atmosphere in the interior of the SMIF pod once the SMIF pod is closed.

In addition, the door of a pod, which is lowered into the processing equipment in the process of transferring articles from the SMIF pod to the processing equipment has a certain volume of uncontrolled atmosphere. Accordingly, gases contained within the pod door can contaminate the controlled atmosphere of the processing equipment as the pod door is introduced into the process equipment.

The present invention provides an apparatus for interconnecting two controlled environments, comprising

a container having a first interior region and a door which makes a seal with the container to establish a controlled environment isolated from ambient atmospheric conditions in said first interior region, said seal maintaining said first interior region at a first pressure;

a processing station having a second interior region maintained at a second pressure which is greater than said first pressure;

a port assembly, provided on said processing station, which provides access to said second interior region, receives said container, and makes a seal with said container, said port assembly having a port door and gas outlet;

means for creating a third pressure, lower than said first pressure in said gas outlet;

means for opening said door of said container and said port door so that said third pressure in said gas outlet removes gas from said first interior region and the difference in the pressures of said first interior region and said second interior region prevents gas from entering said second interior region through said port door.

A preferred embodiment of the invention implements the above defined apparatus as a SMIF system for maintaining the cleanliness of articles to be processed. In this embodiment the container defined above is a SMIF pod which further includes a cassette for holding the articles to be processed, the cassette resting of the door of the pod and the processing station comprises a mechanism for moving the port door to a position in which the cassette is entirely contained within the second interior region.

The present invention further provides a method for interconnecting first and second controlled environments isolated from ambient atmospheric conditions, the first controlled environment being established within a first interior region of a container having a door which makes a seal with the container, said seal maintaining said first interior region at a first pressure;

the second controlled environment being established within a second interior region of a processing station which has a port assembly for providing access to said second interior region receiving said container and making a seal with said container, said port assembly having a port door and gas outlet;

the method comprising:

maintaining said second interior region of said processing station at a second pressure which is greater than said first pressure;

creating a third pressure, lower than said first pressure, in said gas outlet; and

opening said door of said container and said port door whereby said third pressure in said gas outlet removes gas from said first interior region and the difference in the pressures of said first interior region and said second interior region prevents gas from entering said second interior region through said port door.

Therefore the present invention provides a method and apparatus for transferring articles from the SMIF pod to a processing station without contaminating the environment in the processing station.

Further the present invention provides for the use of a conventional SMIF pod with processing equipment having a controllable atmosphere.

More specifically the present invention provides a method of and an apparatus for transferring articles from a SMIF pod to a processing station or transferring articles from a processing station to a SMIF pod in which the environment inside the SMIF pod is purged before this environment is exposed to the atmosphere inside the processing station. One manner of purging the SMIF pod is to create a non-contact gas seal by opening the port door of the processing station by a small amount and to create a differential pressure with respect to the pressure in the SMIF pod. The differential pressure is defined as the relationship of the relative pressures in the SMIF pod, the processing station, a gas inlet to the port assembly of the processing station, and a gas outlet from the port assembly. The differential pressure causes the gas inside the processing equipment to escape through the small aperture between the port door and the processing station, thereby preventing gas from entering the interior region of the processing station through the non-contact gas seal. In conjunction with providing the gas seal, a reduced pressure is created in the port region of the processing equipment in order to remove contaminates and the gas from both the pod door and the interior region of the pod as the pod is opened. The gas seal is maintained until the purging of the interior environment of the SMIF pod is completed. The pod loading or unloading operation includes lowering the pod door to a first position to open the pod and to allow the atmosphere inside the pod door to be purged, lowering the pod door to a second position to allow the interior region of the pod to be purged, and lowering the pod door to a third position in which materials may be transferred to or from the pod.

An additional preferred feature of the invention is the provision of a port door cover or a skirt which creates an isolation region within the processing station. A port door cover isolation region which contains the port door and the isolation region is maintained throughout the purging process. A port door skirt is used in conjunction with a gas seal; in a first phase of two purging processes a gas seal is used and in a second phase an isolation region is established by a contact seal. The port door cover or skirt may be biased to a sealing position by springs connected between the port door cover and the port door.

These and other objects and advantages of the invention will appear more clearly from the following description in which the preferred embodiments of the invention have been set forth in detail in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is an isometric view of a processing station having a canopy for receiving a SMIF pod;
Fig. 1B is a cutaway side view of the processing station of Fig. 1;
Fig. 2 is a sectional view of a SMIF pod and portions of a port assembly for receiving the SMIF pod.
Fig. 3-5 are partial sectional views of a SMIF pod and the port of a processing station with the port door in closed, intermediate, and second intermediate position, respectively;
Figs. 6A, 7A and 8A are partial sectional views of a SMIF pod and the port of a processing station having a port door cover with the port door in first, second, and third positions, respectively; and
Figs. 6B, 7B and 8B are partial sectional views of a SMIF pod and the port of a processing station having a port door skirt, with the port door in first, second, and third positions, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in the context of a SMIF system for storing and transporting wafers and/or articles. However, it is to be understood that a sealable, transportable container in accordance with the present invention may be used to store and transport many other inanimate objects (or materials) as well as living objects such as laboratory animals.

The general structure of a SMIF pod and the mating of a SMIF pod with processing equipment are described in U.S. Patent No. 4,724,874. For completeness, a brief description of the disclosure is provided herein.

Figs. 1 and 2 illustrate a processing station 8 having a canopy 10 which is an easily removable shield that covers the wafer handing mechanism of processing equipment 12. Equipment 12 may be, for example, a photo resist applicator, mask aligner, inspection station or any similar processing equipment. The canopy 10, which is constructed of transparent plastic such as acrylic or Lexan to facilitate visual inspection and/or maintenance within the canopy 10, encloses the handling mechanisms of the processing equipment 12 and a holder 14, such as a wafer cassette holding wafers 16. The environment within the processing equipment 15 is separately maintained and separately cleaned and therefore the equipment 12 need not be installed in a clean room.

A sealable, transportable container (or pod) 18 having a box (or box top) 20 having an interior region 21 and a box door 32 is mounted on the horizontal surface 22 of canopy 10 by a port assembly 24. The port assembly 24 includes a port plate 26, port door 28, and an elevator mechanism 30. Elevator mechanism 30 transports a cassette holder 14, containing the integrated circuit wafers 16 from the interior region 21 of box 20 into the region beneath the canopy 10. In Fig. 1B, port door 28 and box door 32 are shown in the closed position by the dotted lines. A manipulator assembly 44 includes a platform 36, a shaft engagement device 38 and a drive motor 40. The platform 36, extending from the elevator assembly 30, carries the port door 28, the box door 32 and the holder 14 in a vertical direction. The platform 36 is attached by engagement device 38 to a vertical guide 42 of elevator assembly 30.

Typically, guide 42 includes a lead screw (not shown) and the drive motor 40 drives a gear (not shown) which engages the lead screw for driving the platform 36 up or down. When the platform 36 is driven to the closed position, the port door 28 closes the port opening in the canopy 10.

In a similar manner, a manipulator assembly shown generally by the numeral 44 is fastened to a platform 46 which has an engagement means 48 for engaging the vertical guide 42. Manipulator assembly 44 includes a manipulator arm 50 and an engagement head 52 adapted to engage holder 14. By vertical operation of the platforms 36 and 46 and by operation of the manipulator assembly 44, the holder 14 is moved from its position on the box door 32 to a position on the equipment station 13 (as shown by the broken lines).

Fig. 2 shows container 18 mated to port assembly 24 of processing equipment 12. Container 18 is designed for sealably mating with the port assembly 24, and thus box 20 has first and second box top sealing surfaces 54, 56, respectively. Box door 32 has a first box door sealing surface 58 for sealably mating with the first box top sealing surface 54, and gasket 55 between surfaces 54 and 58 provides a seal. Port plate 26 has first and second port plate sealing surfaces 60, 62, respectively. The first port plate sealing surface 60 sealably mates with the second box top sealing surface 56, making a second seal as gasket 57 is compressed.

Port door 28 has a first port door sealing surface 64 which sealably mates with the second port plate sealing surface 62; a third seal is provided by gasket 59. The box top 20 may include a conduit 63 defining a channel between valve 52 and the interior space 21 of box 20. At one end of channel 63 is a filter 69 for filtering fluids (e.g., gasses) passing therethrough.

When the first, second and third seals are made, the interior space 21 of box 20 may be cleaned by alternately evacuating/pressurizing the interior space 21. In order to evacuate interior space 21, injection/extractor 50 is activated to withdraw fluid from interior space 21. As the fluids are withdrawn, they pass through filter 69, through channel 63 and through a coaxial valve (not shown) of injection/extractor 50.

The port door 28 includes a latch actuating mechanism (not shown) for releasing box door 32 from box 20. Wafers 16 can be moved by elevator mechanism 30 and manipulator assembly 44 into the proper position in the processing equipment 12 for processing without human intervention.

A method and apparatus for controlling the environments in a SMIF pod and a processing station during the loading and/or unloading of a SMIF pod, in accordance with the present invention, will be described with reference to Figs. 3-6.

The interior region 15 of processing equipment 12 defines an environment having a pressure P_2, and the interior region 21 of container 18 defines an environment having a pressure P_1. The seal provided between port plate 26 and port door 28 at location 59 (e.g., a gasket or a metal-to-metal seal) isolates region 15 from ambient atmospheric conditions. Likewise, the seal between box 20 and box door 32, provided by gasket 55, isolates region 21 from ambient atmospheric conditions.

Fig. 3 shows a box 20 mated with port plate 26, with both port door 28 and box door 32 in the closed position so that regions 15 and 21 are sealed. Box 20 may be mechanically latched to port plate 26. Box door 32 may include a safety mechanism (interlock) which prevents box door 32 from being opened unless

box 20 is latched to port plate 26. Alternatively, the interlock may be provided through software control of manipulator 44. In addition, box door 32 may be latched to port door 28 by mechanical means; alternatively, box door 32 may be allowed to rest freely on port door 28, held in place by gravity.

Prior to breaking the seals provided by gaskets 55 and 59, so that articles may be transferred from region 21 to region 15, region 15 is maintained in a particle free condition. The particle free condition of region 15 may be provided by, for example, using vacuum pumps to evacuate region 15 and then backfilling region 15 with pure gases obtained from bottles. The gas introduced in environment 15 may be nitrogen (N_2) maintained at a pressure slightly higher than or equal to atmospheric pressure.

An outlet port 94 and an inlet port 95 are provided in port plate 26. An exhausting sink 96, e.g., vacuum pump, may be attached to outlet port 94 to create a reduced pressure in outlet port 94. A source of pure gas 99, for example, bottled nitrogen (N_2) having a purity on the order of 99.999%, is provided at inlet port 95. Inlet and outlet ports 94, 95 may be selectively sealed through the use of one or more valves 98a, 98b. Further, an exhausting sink and a source of gas may be connected to one inlet/outlet port under the control of multiple valves.

The first step in the transfer process, as shown in Fig. 4, is to open port door 28 and box door 32 through downward motion of port door 28. The port door 26 and box door 32 are opened by a small amount in this first step, placing the port door 28 in a first open position. Port plate 26 is designed so that a mating region or port plate 26 forms a non-contact, gas seal 92 with respect to port door 28 when the port door 28 is in the first open position. The non-contact gas seal 92 is essentially a small gap in the order of 25.4μm-2.54 mm (1-100 mils) 380-76μm (15-30 mils) in the preferred embodiment. The size of non-contact gas seal 92 is application dependent, varying with factors such as the type of gas (or gases) utilized and the purity desired. A higher purity requires a smaller gap, whereas a lower purity allows the use of a larger gap. A non-contact seal is desirable because a contact seal would require either scraping of the elements forming the seal or mechanical motion of a sealing element, both of which would tend to generate contaminant particles.

Table 1

Operation / Sealing Method	Loading Processing Station - P_2 protected	Unloading Processing Station - P_2 protected	Unloading Processing Station - P_2 unprotected	SMIF Pod Storage or Transport - P_2 unprotected
Non-contact Gas Seal	$P_3 > P_1$ $P_2 > P_1$ $P_4 < P_1$	$P_3 > P_1$ $P_2 > P_1$ $P_4 < P_1$	$P_3 > P_1$ $P_2 < P_1$ $P_4 < P_1$	$P_3 > P_1$ $P_2 < P_1$ $P_4 < P_1$
Port Door Cover	P_2 Independent $P_3 > P_1$ $P_4 < P_1$	P_2 Independent $P_3 > P_1$ $P_4 < P_1$	N/A	P_2 Independent $P_3 > P_1$ $P_4 < P_1$
Combination: Non-contact Gas Seal and Port Door Skirt	Stage 1 (Gas Seal) $P_2 > P_1$ $P_3 \geq P_1$ $P_4 \leq P_1$ Stage 2 (Contact Seal) P_2 Independent $P_3 > P_1$ $P_4 < P_1$	Stage 1 (Gas Seal) $P_2 > P_1$ $P_3 \geq P_1$ $P_4 \leq P_1$ Stage 2 (Contact Seal) P_2 Independent $P_3 > P_1$ $P_4 < P_1$	Stage 1 (Gas Seal) $P_2 < P_1$ $P_3 \geq P_1$ $P_4 \leq P_1$ Stage 2 (Contact Seal) P_2 Independent $P_3 \geq P_1$ $P_4 \leq P_1$	Stage 1 (Gas Seal) $P_2 < P_1$ $P_3 \geq P_1$ $P_4 < P_1$ Stage 2 (Contact Seal) P_2 Independent $P_3 > P_1$ $P_4 < P_1$

Non-contact gas seal 92 functions in conjunction with a differential pressure. A differential pressure is defined by the pressures P_1 and P_2, and by pressures P_3 in inlet port 95 and P_4 in outlet port 94. Table 1 specifies the relationships of these pressures for various types of seals and various operations.

In operation, an over-pressure in region 15 causes a flow of gas from region 15 through the non-contact seal 92 and into outlet port 94. From outlet port 94, the gas escaping from environment 15 is vented to an

environment external to the SMIF system. The flow of gas out of region 15 through non-contact seal 92 prevents contaminants from entering region 15 through non-contact seal 92. A vacuum in outlet port 94 serves to enhance the flow through non-contact seal 92 and aids in removing the gas escaping from region 15. However, an over-pressure in region 15 is sufficient to exhaust the gasses expelled through non-contact seal 92, and thus an exhausting sink 96 may not be required.

The reduced pressure provided by exhausting sink 96 is also used to evacuate region 21, and a third region 100 within box door 32, thereby removing contaminate particles and gases from these regions. When port door 28 and box door 32 are in the position shown in Fig. 4, a reduced pressure created in outlet port 94 will serve to evacuate region 100. Region 100 houses a latch mechanism (not shown) which protrudes through openings 102 in box door 32 to engage box 20.

In order to evacuate or purge region 21, port door 21 and box door 32 are lowered to the position shown in Fig. 5, so that region 21 is in communication with outlet port 94. Applying a vacuum to region 21 for several minutes is usually sufficient to purge any contaminate from region 21 and the articles contained therein. In order to remove articles from region 21, port door 28 and box door 32 are lowered further, as shown in Fig. 1B.

Figs. 6-8 illustrate the addition of a port door cover 110 or a port door skirt 130 to the system. Port door cover is shown in Figs. 6A, 7A, and 8A and port door skirt 130 is shown in Figs. 6B, 7B, and 8B.

Port door cover 110 forms a seal with port plate 26 through gasket 112. A sealing force is provided by spring 114 which attaches port door cover to port door 28. For simplicity, only one spring is shown. However, it is contemplated that either a single spring attached to a pulley mechanism or multiple springs attached directly between port door cover 110 and port door 28 may be utilized. The sealing force biases port door cover 110 toward port door 28, thereby compressing gasket 112.

Port door cover 110 creates a fourth region 120, which isolates region 15. Port door cover 110 may be used in place of or in addition to the non-contact seal 92. A differential pressure is used to evacuate region 120. For example, a reduced pressure applied to outlet port 94 may be used to evacuate and purge contaminants from region 120; alternatively, a differential pressure may be created by introducing a purge gas at an over-pressure in inlet port 95. Region 120 may be evacuated before or after port door 28 is opened. When port door 28 is in the closed position, as shown in Fig. 6A, spring 114 creates a relatively large biasing force to maintain the seal between port door cover 110 and port plate 26.

Manipulator 44 protrudes through cover 110 to connect to port door 28. Several alternative sealing arrangements may be used in connection with manipulator 44; for example, a non-contact gas seal may be established between manipulator 44 and cover 110, or a bellows or diaphragm (not shown) may be provided.

As port door 28 is lowered to a first intermediate position, as shown in Fig. 7A, box door 32 is adjacent to outlet port 94, and the reduced pressure applied to outlet port 94 will purge the contaminants from the region 100. As purging continues gases and contaminants in region 21 are removed through outlet port 94. Alternatively, as shown in Figs. 1-3, port door 28 may be lowered to a second intermediate position so that region 21 is in direct communication with outlet port 94. Thereafter, as shown in Fig. 8A, port door 28 is lowered further, breaking the seal between port door cover 110 and port plate 26 to allow articles to be transferred from region 21 to region 15 inside processing station 12.

Port door skirt 130 forms a seal with port plate 26 through gasket 132. A sealing force is provided by spring 134 which attaches port door cover to port door 28. For simplicity, only one spring is shown. However, as discussed with respect to the port door cover 110, it is contemplated that either a single spring attached to a pulley mechanism or multiple springs may be utilized. The sealing force biases port door skirt 130 toward port door 28, thereby compressing gasket 132. Guides 136 are attached to port door 28 to control the movement of skirt 130. Because skirt 130 has an opening 138, it is not necessary to provide a seal around manipulator 44.

In operation, the embodiment shown in Figs. 6B, 7B, and 8B uses a differential pressure and combination of a non-contact gas seal and a contact seal to protect region 15 during purging of region 21. Fig. 6B shows port door 28 and box door 32 in the sealed positions. During the purging operation, port door 28 is opened and a non-contact gas seal, as shown in Fig. 4 protects region 15. A differential pressure, as specified in Table 1, maintains the non-contact gas seal, while port door 28 is lowered to the position shown in Fig. 7B to contact gasket 140, thereby forming a seal between port door 28 and skirt 130. The seal between port door 28 and skirt 130 isolates region 15, allowing the purging operation to continue without a continued flow of gas out of region 15. Fig. 8B shows port door 28 in the fully lowered position to allow articles to be transferred from region 21 to region 15.

In general, container 18 remains attached to processing equipment 12 during the period that the articles transferred from container 18 (region 21) to processing station 12 (region 15) are processed. In this

situation, the articles may be returned directly to container 18. However, this is not always the situation. For example, selected articles from several containers may be processed simultaneously, requiring several repetitions of the unloading process in order to collect the selected articles to be processed.

Reloading articles into a container 18 involves the same process as unloading the container 18. In particular, the process of purging regions 21, 100 and 120 while region 15 is sealed either by a non-contact seal, a port door cover 110, or a port door skirt 130 is performed prior to transferring articles from processing station 12 (region 15) to container 18 (region 21).

The many features and advantages of the present invention will be apparent to those skilled in the art from the Description of the Preferred Embodiments and the Drawings. Accordingly, the following claims are intended to cover all modifications and equivalents falling within the scope of the invention.

Claims

1. An apparatus for interconnecting two controlled environments, comprising

   a container (20) having a first interior region (21) and a door (32) which makes a seal with the container to establish a controlled environment isolated from ambient atmospheric conditions in said first interior region (21), said seal maintaining said first interior region at a first pressure (P_1);

   a processing station (12) having a second interior region (15) maintained at a second pressure (P_2) which is greater than said first pressure (P_1);

   a port assembly (26), provided on said processing station (12), which provides access to said second interior region (15), receives said container (20), and makes a seal with said container (20), said port assembly having a port door (28) and gas outlet (94);

   means (96) for creating a third pressure (P_4), lower than said first pressure (P_1) in said gas outlet (94);

   means for opening said door (32) of said container and said port door (28) so that said third pressure (P_4) in said gas outlet (94) removes gas from said first interior region (21) and the difference in the pressures of said first interior region (21) and said second interior region (15) prevents gas from entering said second interior region (15) through said port door (28).

2. An apparatus for removing articles from a sealable transportable container comprising apparatus according to claim 1 and means for removing articles from said container (20) when said door (32) of said container (20) and said port door (28) are opened.

3. A SMIF system for maintaining the cleanliness of articles to be processed comprising apparatus according to claim 1 in which said container (20) is a SMIF pod which further includes a cassette (16) for holding the articles, said cassette resting on said door (32) of the pod; said processing station (12) further comprising a mechanism (30) for moving said port door (28) to a position in which said cassette (16) is entirely contained within said second interior region (15).

4. A SMIF system according to claim 3, further comprising isolation means, provided in said second interior region (15) of said processing station (12), for providing an isolation region isolating said port door from the remaining portion of said interior region of said processing station and for preventing gas from entering said interior region of said processing station from said isolation region when said port door is in said first and second positions.

5. A SMIF system according to claim 4, wherein said isolation means comprises a port door cover, and means for biasing said port door cover so that said port door cover forms a seal with said port plate.

6. A method for interconnecting first and second controlled environments isolated from ambient atmospheric conditions, the first controlled environment being established within a first interior region (21) of a container (20) having a door (32) which makes a seal with the container, said seal maintaining said first interior region at a first pressure (P_1);

   the second controlled environment being established within a second interior region (15) of a processing station (12) which has a port assembly (26) for providing access to said second interior region (15) receiving said container (20) and making a seal with said container (20), said port assembly having a port door (28) and gas outlet (94);

   the method comprising:

   maintaining said second interior region (15) of said processing station at a second pressure (P_2)

which is greater than said first pressure (P_1);

creating a third pressure (P_4), lower than said first pressure (P_1), in said gas outlet (94); and

opening said door (32) of said container and said port door (28) whereby said third pressure (P_4) in said gas outlet (94) removes gas from said first interior region (21) and the difference in the pressures of said first interior region (21) and said second interior region (15) prevents gas from entering said second interior region (15) through said port door (28).

Patentansprüche

1. Gerät zum Zwischenverbinden von zwei kontrollierten Umgebungen, das
einen Behälter (20), der einen ersten Innenbereich (21) und eine Tür (32) besitzt, die eine Dichtung mit dem Behälter herstellen, um eine kontrollierte Umgebung isoliert von atmosphärischen Umgebungszuständen in dem ersten Innenbereich (21) einzurichten, wobei die Dichtung den ersten Innenbereich auf einem ersten Druck (P_1) aufrecht erhält;
eine Behandlungsstation (12), die einen zweiten Innenbereich (15) besitzt, der unter einem zweiten Druck (P_2) gehalten wird, der größer als der erste Druck (P_1) ist;
eine Durchlaßanordnung (26), die an der Behandlungsstation (12) vorgesehen ist, die einen Zugang zu dem zweiten Innenbereich (15) schafft, der den Behälter (20) aufnimmt und eine Dichtung mit dem Behälter (20) vornimmt, wobei die Durchlaßanordnung eine Durchlaßtür (28) und einen Gasauslaß (94) besitzt;
eine Einrichtung (96) zur Erzeugung eines dritten Drucks (P_4), der niedriger als der erste Druck (P_1) in dem Gasauslaß (94) ist;
eine Einrichtung zum Öffnen der Tür (32) des Behälters und der Durchlaßtür (28) so, daß der dritte Druck (P_4) in dem Gasauslaß (94) Gas von dem ersten Innenbereich (21) entfernt und die Differenz in den Drücken des ersten Innenbereichs (21) und des zweiten Innenbereichs (15) verhindert, daß Gas von dem zweiten Innenbereich (15) durch die Durchlaßtür (28) eintritt;
aufweist.

2. Gerät zum Entfernen von Gegenständen von einem dichtbaren, transportablen Behälter, der ein Gerät gemäß Anspruch 1 und eine Einrichtung zum Entfernen von Gegenständen von dem Behälter (20), wenn die Tür (32) des Behälters (20) und die Durchlaßtür (28) geöffnet werden, aufweist.

3. SMIF-System zur Beibehaltung der Reinheit von Gegenständen, die behandelt werden sollen, das ein Gerät gemäß Anspruch 1 aufweist, bei dem der Behälter (20) eine SMIF-Schale ist, die weiterhin eine Kassette (16) zum Halten der Gegenstände umfaßt, wobei die Kassette auf der Tür (32) der Schale ruht; wobei die Behandlungsstation (12) weiterhin einen Mechanismus (30) zum Bewegen der Durchlaßtür (28) zu einer Position, in der die Kassette (16) vollständig innerhalb des zweiten Innenbereichs (15) enthalten ist, aufweist.

4. SMIF-System nach Anspruch 3, das weiterhin eine Isolationseinrichtung aufweist, die in dem zweiten Innenbereich (15) der Behandlungsstation (12) vorgesehen ist, und zwar zum Bilden eines Isolationsbereichs, der die Durchlaßtür gegenüber dem verbleibenden Teil des Innenbereichs der Behandlungsstation isoliert, und zum Verhindern, daß Gas von dem Innenbereich der Behandlungsstation von dem Isolationsbereich eintritt, wenn sich die Durchlaßtür in der ersten und der zweiten Position befindet.

5. SMIF-System nach Anspruch 4, wobei die Isolationseinrichtung einen Durchlaßtürdeckel und eine Einrichtung zum Vorspannen des Durchlaßtürdeckels so, daß der Durchlaßtürdeckel eine Dichtung mit der Durchlaßplatte bildet, aufweist.

6. Verfahren zum Zwischenverbinden der ersten und der zweiten, kontrollierten Umgebung, die gegenüber atmosphärischen Umgebungsbedingungen isoliert sind, wobei die erste, kontrollierte Umgebung innerhalb eines ersten Innenbereichs (21) des Behälters (20), der eine Tür (32) besitzt, die eine Dichtung mit dem Behälter herstellt, eingerichtet wird, wobei die Dichtung den ersten Bereich auf einem ersten Druck (P_1) hält;
wobei die zweite, kontrollierte Umgebung innerhalb eines zweiten Innenbereichs (15) einer Behandlungsstation (12) eingerichtet wird, die eine Durchlaßanordnung (26) zum Bilden eines Zugangs zu dem zweiten Innenbereich (15), der den Behälter (20) aufnimmt, besitzt und eine Dichtung mit dem zweiten Behälter (20) vornimmt, wobei die Durchlaßanordnung eine Durchlaßtür (28) und einen Gasauslaß (94)

besitzt; wobei das Verfahren aufweist:
Halten des zweiten Innenbereichs (15) der Behandlungsstation auf einem zweiten Druck (P_2), der größer als der erste Druck (P_1) ist;
Erzeugen eines dritten Drucks (P_4), der niedriger als der erste Druck (P_1) ist, und zwar in dem Gasauslaß (94); und
Öffnen der Tür (32) des Behälters und der Durchlaßtür (28), wobei der dritte Druck (P_4) in dem Gasauslaß (94) Gas von dem ersten Innenbereich (21) wegnimmt und die Differenz in den Drücken des ersten Innenbereichs (21) und des zweiten Innenbereichs (15) verhindert, daß Gas von dem zweiten Innenbereich (15) durch die zweite Durchlaßtür (28) eintritt.

Revendications

1. Appareil d'interconnexion de deux environnements soumis à des conditions réglées, comprenant
   un récipient (20) ayant une première région interne (21) et une porte (32) qui ferme de manière étanche le récipient pour l'établissement d'un environnement soumis à des conditions réglées, isolé des conditions atmosphériques ambiantes dans la première région interne (21), le dispositif d'étanchéité maintenant la première région interne à une première pression (P_1),
   un poste de traitement (12) ayant une seconde région interne (15) maintenue à une seconde pression (P_2) qui est supérieure à la première pression (P_1),
   un ensemble (26) à orifice disposé sur le poste de traitement (12) et qui donne accès à la seconde région interne (15), loge le récipient (20), et forme un joint étanche avec le récipient (20), l'ensemble à orifice ayant une porte (28) d'orifice et une sortie de gaz (94),
   un dispositif (96) de création d'une troisième pression (P_4) qui est inférieure à la première pression (P_1) à la sortie de gaz (94), et
   un dispositif destiné à ouvrir la porte (32) du récipient et la porte (28) de l'orifice afin que la troisième pression (P_4) régnant à la sortie de gaz (94) chasse le gaz de la première région interne (21), et que la différence de pression entre la première région interne (21) et la seconde région interne (15) empêche l'entrée du gaz dans la seconde région interne (15) par la porte (28) de l'orifice.

2. Appareil d'extraction d'articles d'un récipient transportable qui peut être fermé de manière étanche, comprenant un appareil selon la revendication 1, et un dispositif destiné à retirer les articles du récipient (20) lorsque la porte (32) du récipient (20) et la porte (28) de l'orifice sont ouvertes.

3. Ensemble SMIF destiné à la conservation de la propreté d'articles à traiter, comprenant un appareil selon la revendication 1 dans lequel le récipient (20) est une nacelle SMIF qui comporte en outre une cassette (16) destinée à contenir les articles, la cassette étant en appui sur la porte (32) de la nacelle, le poste de traitement (12) comportant en outre un mécanisme (30) destiné à déplacer la porte (28) de l'orifice à une position dans laquelle la cassette (16) est entièrement contenue à l'intérieur de la seconde région interne (15).

4. Ensemble SMIF selon la revendication 3, comprenant en outre un dispositif d'isolement placé dans la seconde région interne (15) du poste de traitement (12) et destiné à former une région d'isolement de la porte de l'orifice par rapport à la partie restante de la région interne du poste de traitement, et destiné à empêcher l'entrée du gaz dans la région interne du poste de traitement depuis la région d'isolement lorsque la porte de l'orifice est dans la première et dans la seconde position.

5. Ensemble SMIF selon la revendication 4, dans lequel le dispositif d'isolement comporte un couvercle de porte d'orifice et un dispositif de rappel du couvercle de porte d'orifice afin que le couvercle de porte d'orifice forme un joint étanche avec la plaque de l'orifice.

6. Procédé d'interconnexion d'un premier et d'un second environnement soumis à des conditions réglées, isolés des conditions atmosphériques ambiantes, le premier environnement soumis à des conditions réglées étant établi à l'intérieur d'une première région interne (21) d'un récipient (20) ayant une porte (32) et formant un joint étanche avec le récipient, le joint étanche maintenant la première région interne à une première pression (P_1),
   le second environnement soumis à des conditions réglées étant établi dans une seconde région interne (15) d'un poste de traitement (12) qui possède un ensemble (26) à orifice destiné à donner accès à la seconde région interne (15) qui reçoit le récipient (20) et forme un joint étanche avec le

récipient (20), l'ensemble à orifice ayant une porte (28) d'orifice et une sortie de gaz (94),

le procédé comprenant :

le maintien de la seconde région interne (15) du poste de traitement à une seconde pression (P_2) qui est supérieure à la première pression (P_1),

la création d'une troisième pression (P_4) qui est inférieure à la première pression (P_1) à la sortie de gaz (94), et

l'ouverture de la porte (32) du récipient et de la porte (28) de l'orifice afin que la troisième pression (P_4) à la sortie de gaz (94) chasse le gaz de la première région interne (21) et que la différence des pressions entre la première région interne (21) et la seconde région interne (15) empêche l'entrée du gaz dans la seconde région interne (15) par l'intermédiaire de la porte de l'orifice (28).

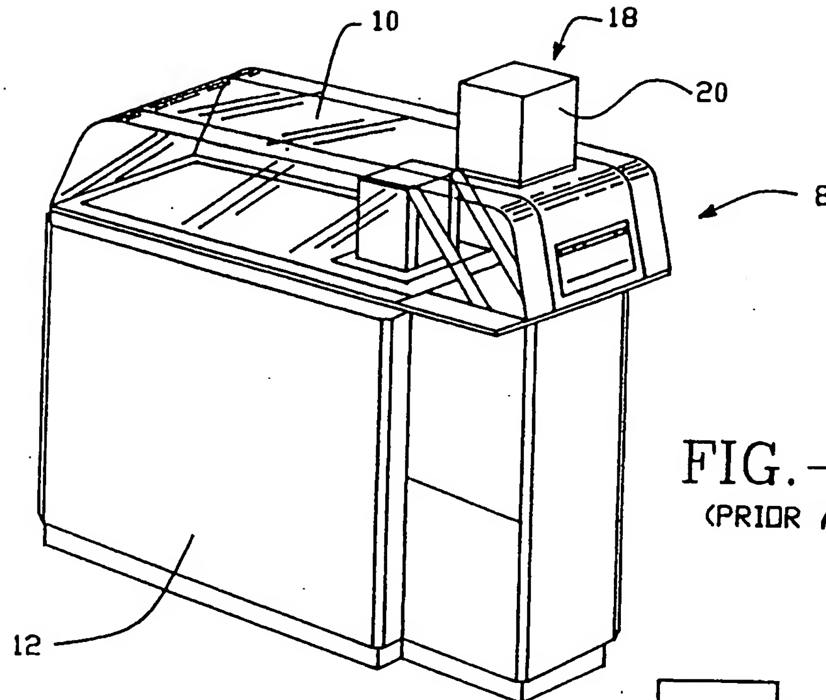


FIG.—1A
(PRIOR ART)

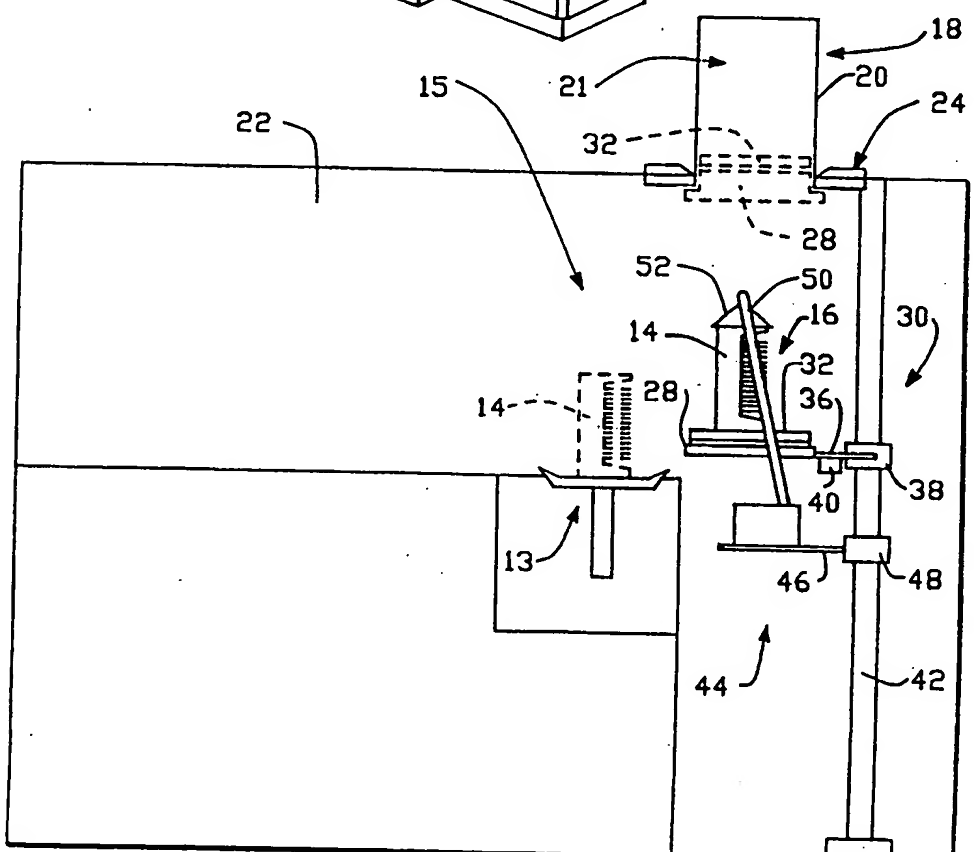


FIG.—1B
(PRIOR ART)

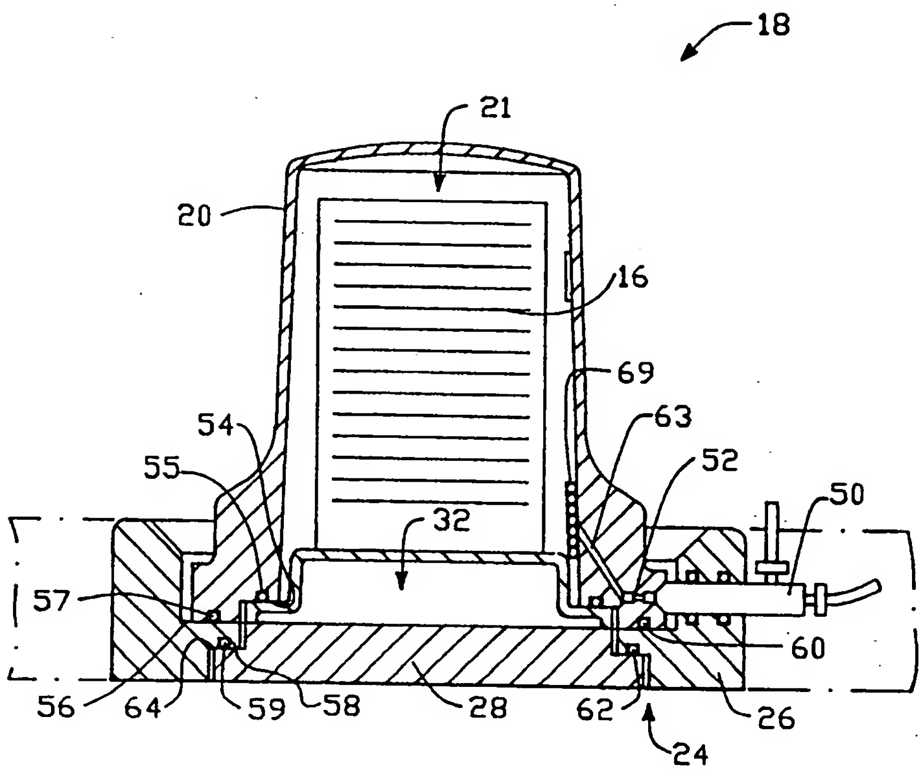


FIG.–2
(PRIOR ART)

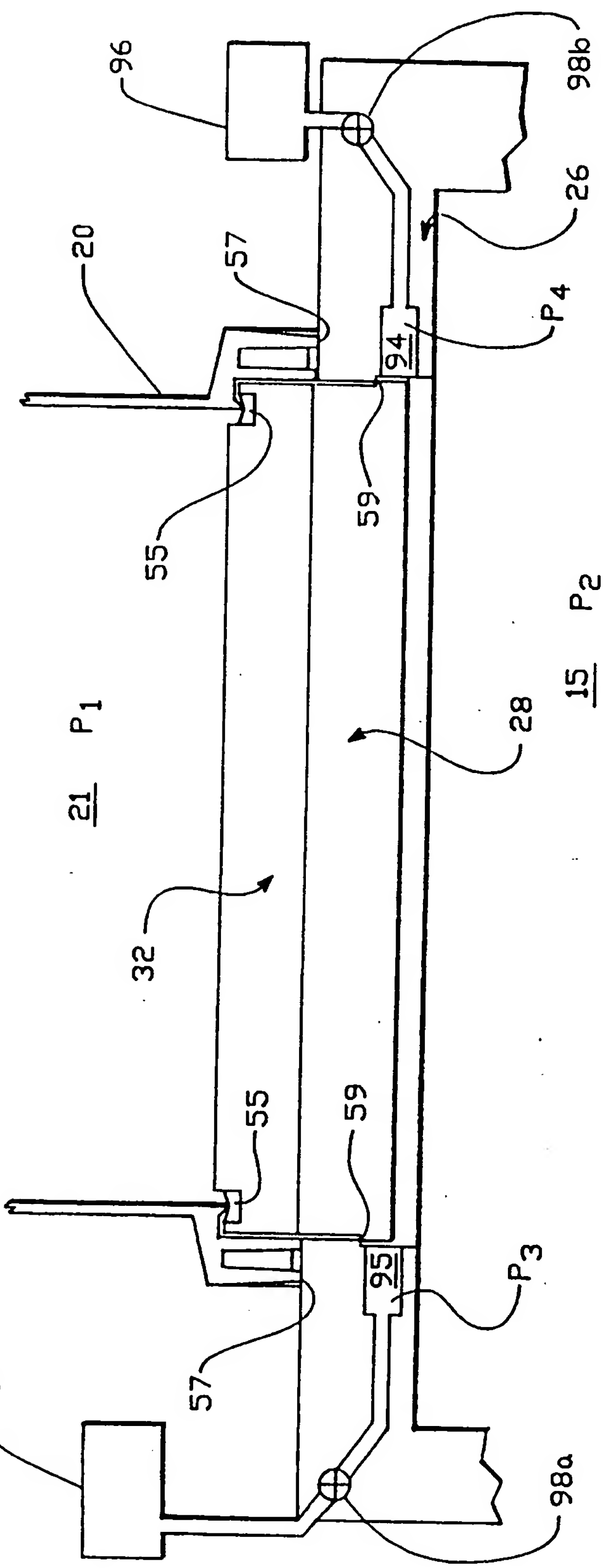


FIG. — 3

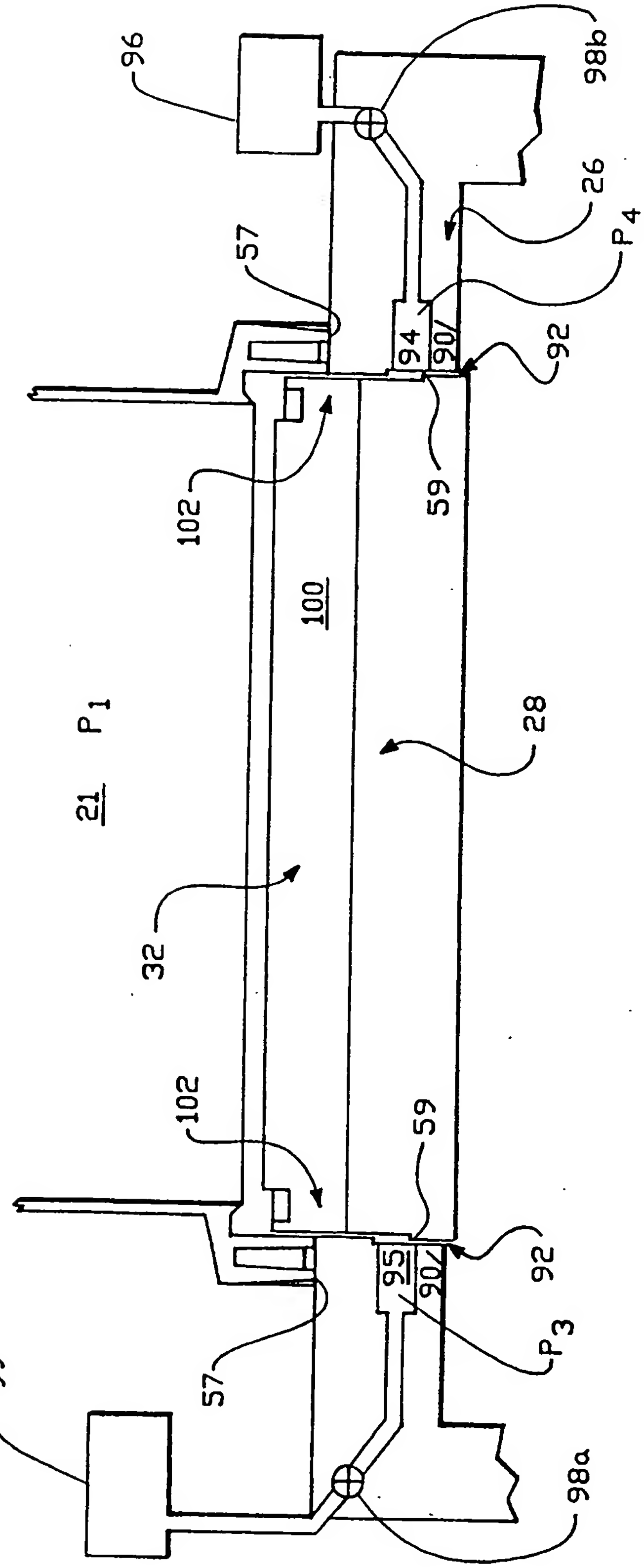

96
98b
57
26
P4
94
90
92
102
59
100
21
P1
28
32
102
59
57
92
95
90
P3
99
98a

FIG. — 4

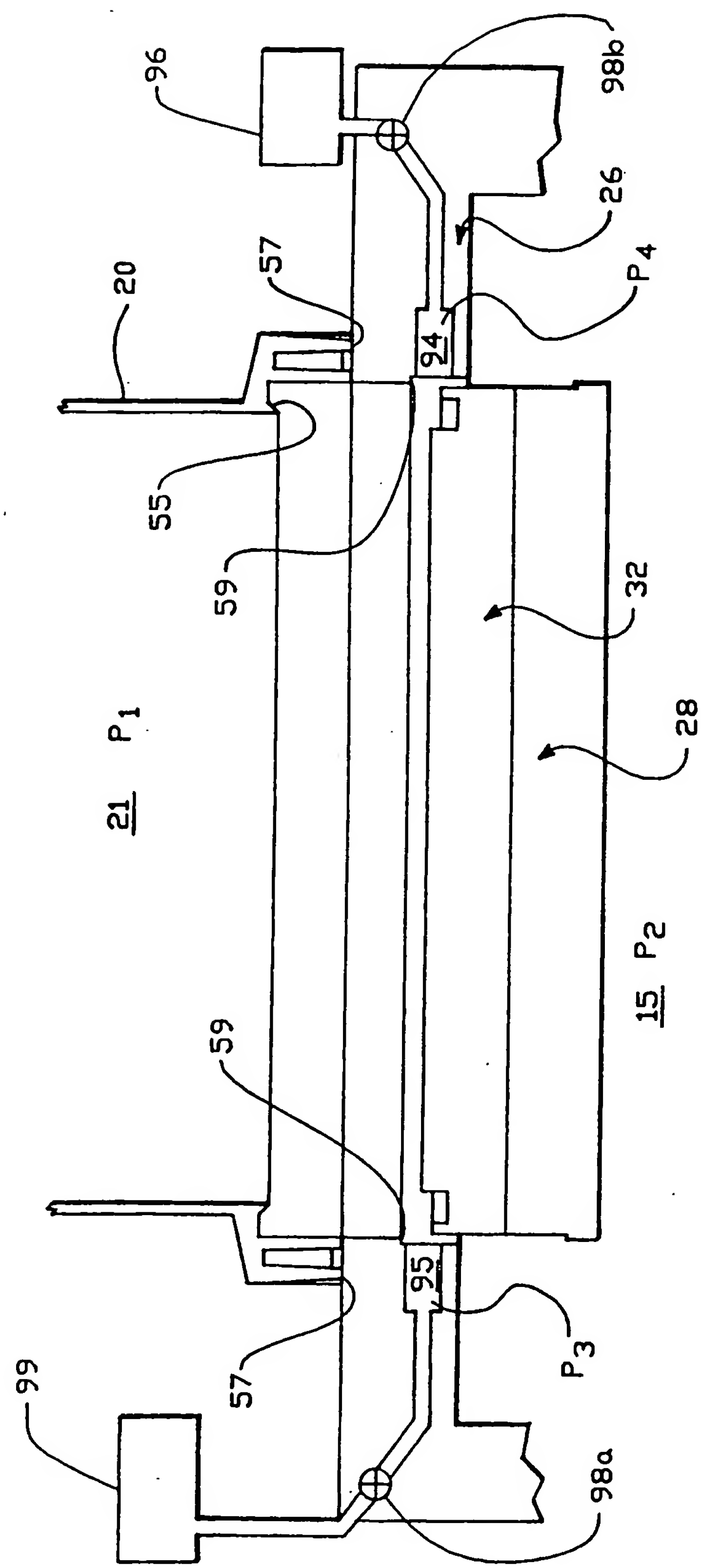
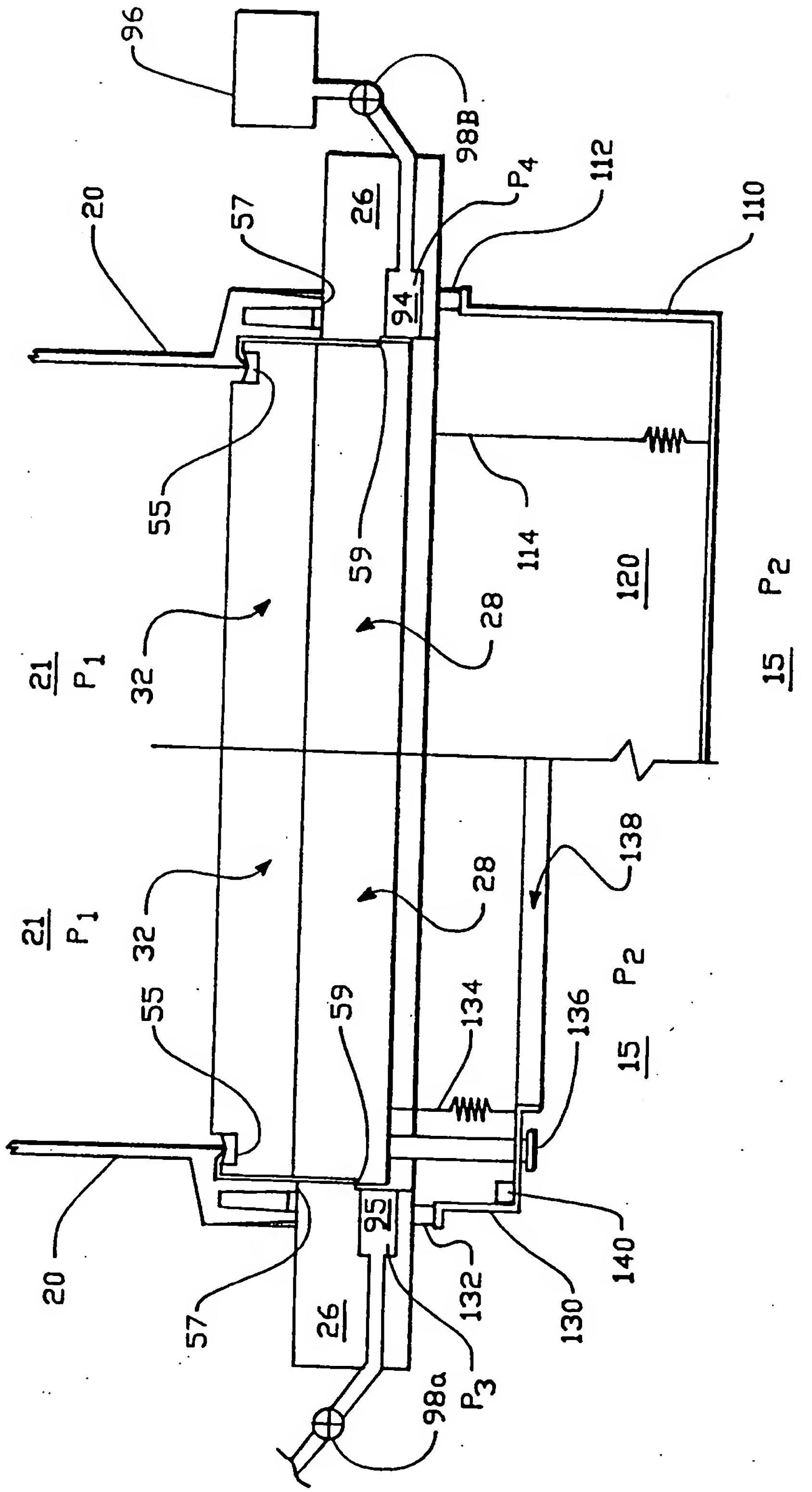
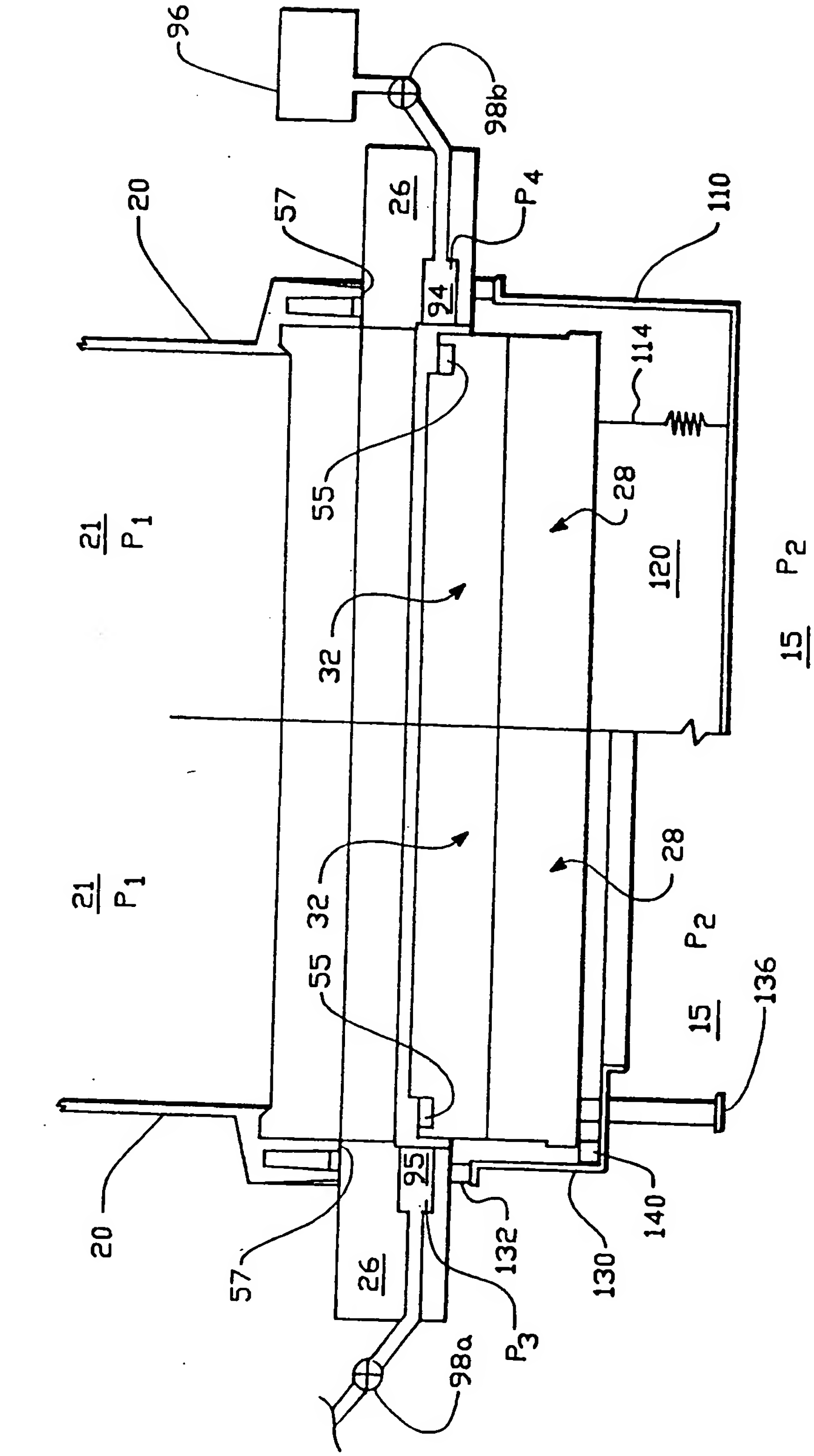


FIG. — 5

FIG.—6A

FIG.—6B


20
57
26
96
98B
P_4
94
112
110
55
59
114
120
P_2
21
P_1
32
28
15
138
134
136
95
132
130
140
98a
P_3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98b
20
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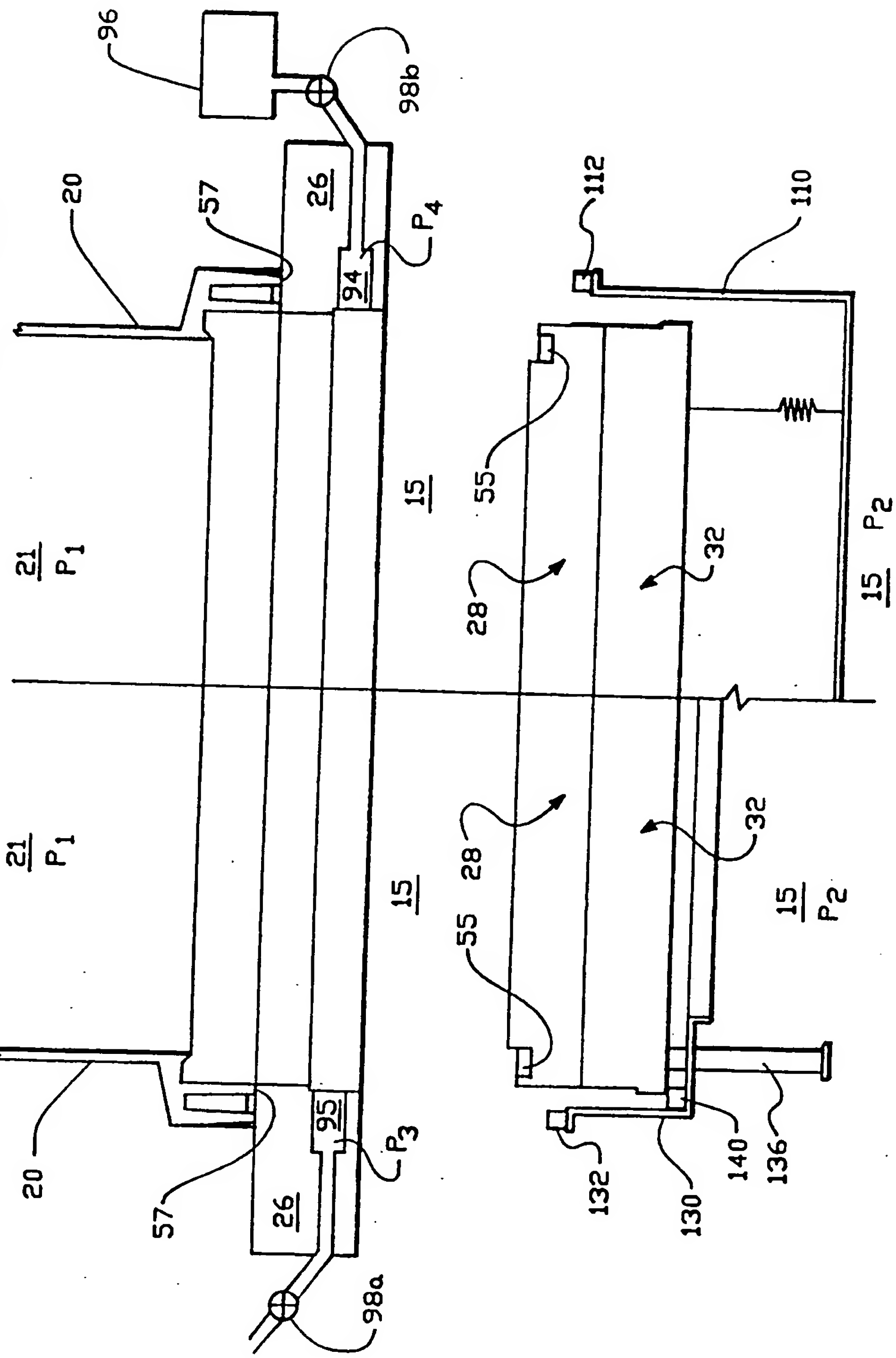
P4
110
94
114
55
21
P1
28
120
P2
15
32
21
P1
32
28
55
P2
15
136
20
57
95
26
132
P3
130
140
98a

FIG. —7A

FIG. —7B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98b
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94
P4
20
57
112
110
21
P1
15
55
28
32
P2
98a
95
P3
130
132
140
136

FIG. —8A

FIG. —8B